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Federal Aviation Administration
William J. Hughes Technical Center
Atlantic City International Airport, NJ 08405

Evaluation of Modified Air Traffic Control Phraseology for Area Navigation (RNAV) Standard Instrument Departure Clearances

Phase II: Operational Validation

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Technical Report

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16. Abstract During the past two years the FAA has begun the deployment of new RNAV Standard Terminal Arrivals (STARs) and SIDs at selected airports across the U.S. Working in conjunction with cooperating air carriers, the FAA has closely monitored operational performance and accrued benefits. Although recordings of the accuracy and consistency of flight paths using the new RNAV procedures have shown excellent performance in many cases, several exceptions have been noted in the case of aircraft departing on RNAV SIDs. Some of the deviations from the required three-dimensional departure track have been attributed to navigational equipment failures and errors. However, many cases of non-compliance with an RNAV SID clearance have been traced to human factors issues associated with pilot/controller or pilot/Flight Management System (FMS) interaction. The FAA and industry have taken actions to determine the nature of the human issues associated with the problem, and to develop more effective guidance and instructions to pilots and controllers for the use of RNAV SIDs.			
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EXECUTIVE SUMMARY

During the past two years the Federal Aviation Administration (FAA) has begun the deployment of new Area Navigation (RNAV) Standard Terminal Arrivals (STARs) and Standard Instrument Departures (SIDs) at selected airports across the National Airspace System (NAS). Working in conjunction with the NAS users, the FAA has closely monitored operational performance and accrued benefits. Although RNAV procedures have shown promise, some deviations from controller clearances have caused either the shut down of, or modification to, RNAV procedures. Many cases of non-compliance with an RNAV SID clearance have been traced to human factors issues associated with pilot/controller or pilot/Flight Management System (FMS) interaction. These issues included misunderstandings concerning the actual clearance sent, and misunderstandings of the intent of the clearance. Because of these anomalies, the FAA and industry have taken actions to determine the nature of the human issues associated with the problem, and to develop more effective guidance and instructions to pilots and controllers for the use of RNAV SIDs.

In analyzing the failures to comply with RNAV SID clearances, one problem that surfaced was the Air Traffic Control (ATC) phraseology in use for issuing the clearance to rejoin the departure route and return the aircraft to the SID. This clearance did not effectively communicate the intent of the issued instruction to all pilots. The Pilot/Controller Phraseology and Procedures Action Team (P/CPP AT), is an action team under the Departure and Landing Workgroup of the Performance Based Operational Aviation Rulemaking Committee, and was established to address such pilot/controller procedure and phraseology issues. The P/CPP AT is composed of air traffic, aviation, pilot, and controller union subject matter experts, and has proposed changes to the FAA Order 7110.65, the Aeronautical Information Manual (AIM), and the Aeronautical Information Publication (AIP). The P/CPP AT has identified an operational need to establish “climb via” procedures and phraseology for SIDs similar to the “descend via” procedures and phraseology in current use for STARs. Accordingly, the P/CPP AT drafted new procedures and phraseology for addition to FAA Order 7110.65 (Air Traffic Control), paragraph 4-5-7, describing the “climb via” instructions [see Appendix A: Draft Document Change Proposal (DCP)]. The proposed phraseology was developed primarily to address potential misunderstandings of RNAV SIDs, however, the issues addressed by the new phraseology also will apply to all SIDs.

The primary focus of this effort was the operational validation of draft “climb via” procedures and phraseology. Within the context of an RNAV SID, we also investigated issues surrounding the effective depiction of a “SID Top Altitude” (the highest altitude an aircraft is cleared to on a given departure). The goal was to exercise these new ATC instructions in an operational environment and assess the clarity of the climb via instruction through pilot performance and subjective feedback. The participant pool consisted of Boeing 747 and 737 pilots who had a wide range of prior RNAV SID experience.

Overall, the climb via concept was viewed favorably by the majority of the participants, and they were enthusiastic that the FAA was soliciting input from the user’s perspective prior to implementation. Most pilots agreed that with some minimal training “climb via” would be beneficial to NAS operations.

1. Introduction

1.1 Purpose

This document presents the results of the second of a two-phased study that has been conducted by the Simulation and Analysis Group of the Federal Aviation Administration (FAA) William J. Hughes Technical Center (WJHTC) to evaluate modified phraseology and procedures for use by terminal air traffic controllers when issuing Conventional and Area Navigation (RNAV) Standard Instrument Departure clearances (SIDs). The first phase was completed in November 2004. The effort described here was completed in May 2005.

1.2 Project Background

Area navigation (RNAV) is a navigation method that permits aircraft to operate on any desired flight path within the coverage of station-referenced navigation aids [e.g. Distance Measuring Equipment (DME)], within the limits of equipment onboard the aircraft [e.g. Global Positioning System (GPS)], or a combination of both. The FAA has committed to the evolution of the National Airspace System (NAS) from conventional navigation over routes defined by ground emitted navigation aid signals to a system that will rely exclusively on the use of RNAV. As a part of this restructuring of NAS airspace, the FAA is implementing a performance-based navigation concept in which aircraft will be required to comply with specified performance and functional requirements to conduct RNAV procedures. Under the concept of Required Navigation Performance (RNP), individual aircraft will be qualified to fly routes and procedures defined by specific functional RNP levels.

Originally used as a tool for flying conventional ground-based routes, RNAV is being used to permit direct flight between any two points in en route airspace that can be defined solely as geographical coordinates. In addition, RNAV procedures are being designed and implemented for terminal departures and arrivals. The potential benefits of introducing these new procedures for appropriately equipped aircraft include: 1) more fuel efficient and time saving routings, 2) reduced dependence on radar vectoring, altitude and speed assignments that contribute to frequency congestion, and 3) more efficient use of inherently limited terminal airspace.

1.3 Problem and Proposed Solution

During the past two years the FAA has begun the deployment of new RNAV Standard Terminal Arrivals (STARs) and SIDs at selected airports across the U.S. Working in conjunction with cooperating air carriers, the FAA has closely monitored operational performance and accrued benefits. Although recordings of the accuracy and consistency of flight paths using the new RNAV procedures have shown excellent performance in many cases, several exceptions have been noted in the case of aircraft departing on RNAV SIDs. Some of the deviations from the required three-dimensional departure track have been attributed to navigational equipment failures and errors. However, many cases of non-compliance with an RNAV SID clearance have been traced to human factors issues associated with pilot/controller or pilot/Flight Management System (FMS) interaction. These issues included misunderstandings concerning the actual clearance sent, and misunderstandings of the intent of the clearance. Because of these anomalies, the FAA and industry have taken actions to determine the nature of the human issues associated with the problem, and to develop more effective guidance and instructions to pilots and controllers for the use of RNAV SIDs.

In analyzing the failures to comply with RNAV SID clearances, one problem that surfaced was the Air Traffic Control (ATC) phraseology in use for issuing the clearance to join the departure route and for returning aircraft to the SID after issuing a required altitude, speed, and/or heading change may not have effectively communicated the intent of the issued instruction to all pilots. The Pilot/Controller Phraseology and Procedures Action Team (P/CPP AT)), is an action team under the Departure and Landing Workgroup of the Performance Based Operational Aviation Rulemaking Committee, and was established to address such pilot/controller procedure and phraseology issues. The P/CPP AT is composed of air traffic, aviation, pilot, and controller union subject matter experts, and has proposed changes to the FAA Order 7110.65, the Aeronautical Information Manual (AIM), and the Aeronautical Information Publication (AIP). The P/CPP AT has identified an operational need to establish “climb via” procedures and phraseology for SIDs similar to the “descend via” procedures and phraseology in current use for STARs. Accordingly, the P/CPP AT drafted new procedures and phraseology for addition to FAA Order 7110.65 (Air Traffic Control), paragraph 4-5-7, describing the “climb via” instructions [see Appendix A: Draft Document Change Proposal (DCP)]. The proposed phraseology was developed primarily to address potential misunderstandings of RNAV SIDs, however, the issues addressed by the new phraseology will apply to all SIDs.

2. Objectives

This effort was conducted in two phases. The first phase, completed in the fall of 2004, was a series of cognitive walkthroughs conducted with commercial and general aviation pilots. The walkthroughs were designed to elicit narrative descriptions of the actions pilots would take in the context of selected departure scenarios in order to characterize the nature of any potential problem(s) that may exist in interpreting and executing RNAV SID clearances using the proposed “climb via” phraseology. The second phase of this effort focused exclusively on the issues that were identified as potential problems during the cognitive walkthroughs. These issues ranged from pilot misunderstandings of clearances to the potential inability of the onboard flight management system (FMS) to properly execute those clearances. This effort was conducted in flight training simulators and involved assessment of pilot responses to several different scenarios that were specifically designed to address the issues raised in phase one. In addition, pilot/co-pilot communication, and the associated interaction with their navigational equipment as a function of scenario type were examined.

3. Method

3.1 Participants

Twenty-two flight crews (44 pilots) participated in two weeks of simulation. Two participants were not current line pilots. One was a recent American Airlines retiree (747) and the other was a 737 flight instructor for the Federal Aviation Administration. All others were current, and the airlines represented by the participants included United Airlines, American Airlines, Air Tran Airways, Northwest Airlines, Southwest Airlines, and Cathay Pacific Airways.

3.2 Simulation Environment

The simulations were conducted over a two-week period with two types (747 and 737) of certified full motion cockpit simulators. The Boeing 747-400 is located within the Crew-Vehicle Systems Research Facility (CVSRF) at the NASA Ames Research Center, in Moffet Field, CA., and is a fully detailed replica of a B747 flight deck, in which all instruments, controls, and

switches operate in the same manner as in the actual aircraft. The B747-400 features a digital control loading system, a six-degree-of-freedom synergistic motion system, and a fully integrated flight management system that provides aircraft guidance and control. Digital sound systems provide aural cues in the cockpit, while a programmable visual display system provides a 180-degree horizontal/ 40-degree vertical field of view. The Boeing 737-800 is located at the Mike Monroney Aeronautical Center, in Oklahoma City, Oklahoma, and includes a heads-up-display (HUD). The B737 has the same capabilities as the 747 simulator, but with a different flight management system. Both simulators offered digital video/audio recording capabilities which allowed the research team to conduct post simulation content analyses on crew resource management (CRM).

3.3 Procedures

Prior to the start of the exercise and data collection, each pilot read and signed an informed consent form explaining that their participation in this study was strictly voluntary and that their privacy will be protected (see Appendix B). The pilots were then interviewed to obtain information regarding the primary aircraft type and equipage, the pilot's flight background, and his or her experience flying RNAV terminal procedures. Following the background interview, half of the crews were allowed to review a generic information bulletin similar to those developed by airline operators for teaching new cockpit procedures (see Appendix C) prior to entering the simulator.

For the present study, this bulletin covered the subject of executing RNAV SID procedures and the proposed "climb via" phraseology to be used by ATC. This bulletin was based upon the draft FMS/RNAV training program requirement that was prepared for the purpose of ensuring that aircrews are able to competently conduct RNAV SIDs and Standard Terminal Arrival Routes (STARs). The other half of the crews did not receive the bulletin and were led to the simulator immediately following their background interviews. Once the simulator door was closed and participants had settled in, they were allowed to fly one or two practice departures. These practice runs offered the participants the opportunity to get acquainted with the simulation environment and each others' operating procedures (in the case where the flight crew was composed of participants from two different airlines). Following the practice runs, they were given the test case SID (Jeppesen) and instructions to prepare them for the assessment scenarios i.e., runway assignment and takeoff weight. These standard departure plates include a graphical representation (not to scale) of the SID showing all route legs, compass directions, leg mileages, waypoints, and restrictions for performing the procedure. The departure procedure also includes textual information describing the SID route from each departure runway, take-off minimums, ATC contact frequencies, and relevant notes.

3.4 Airspace and Scenarios

All of the RNAV scenarios were conducted using the Las Vegas/McCarran International Airport (LAS) airspace and the SHEAD THREE DEPARTURE (RNAV) SID (see Figure 1). The SHEAD THREE was selected because it contains restrictions to cross waypoints at or below, at and at or above specified altitudes. It also includes waypoints without associated restrictions. The environment provided by this SID permitted an examination of several test scenarios where misunderstandings of clearances or the ability of the FMS to execute clearances may cause deviations or lead to ambiguity in the cockpit. Four test scenarios were developed consisting of joining the SID enroute, and clearances to depart and rejoin the SID where confusion has existed

regarding appropriate altitudes (see Table 1). A more detailed description and the associated ATC phraseology for each scenario can be found in Appendix D. The clearances issued varied with the type of scenario (rejoining the SID, speed restrictions, altitude change, etc.). In these scenarios, terminology from the verbal departure clearance that provides the aircraft's initial altitude limit (e.g. "Maintain 19,000 Feet") was omitted. Instead, a note was published on the SID specifying the SID top altitude limit. In the Phase One cognitive walkthroughs, this note was found to reduce confusion concerning the full clearance to climb to the initial altitude limit, and was therefore used in the present study (see Appendix E). Some participants, however, were from airlines that use pre-departure clearances (PDC's) in lieu of verbal departure clearances. For those participants, their PDC's were modified accordingly. All flight crews experienced all four scenarios, and the presentation order was counterbalanced to eliminate sequence effects. Each scenario began prior to takeoff with a departure clearance and with the aircraft situated at the appropriate end of the assigned runway. In addition, simulator motion was enabled for all runs and there were no prescribed anomalies (engine outs, clear air turbulence, etc.).

Table 1. Scenario Descriptions

Scenario	Event	SID	Runway
ONE	Speed change and downstream SID restriction change	SHEAD 3	25R
TWO	SID altitude restriction change, followed by a short cut including "maintain FL190" in clearance	SHEAD 3	25R
THREE	Vector off SID followed by short cut back onto SID	SHEAD 3	25R
FOUR	SID short cut, followed by vector (to join SID)	SHEAD 3	7L

3.4.1 Data Collection

Two members of the P/PPP AT research team sat in the cockpit behind the flight crew. One member performed the role of ATC issuing clearances and interacting with the flight crew as they would if controlling live traffic while the other member recorded events and whether or not the pilot and/or equipment complied with the scenario-specific clearances. Following the completion of the test runs, crews were debriefed in the cockpit. This debrief consisted of the research team soliciting feedback from the participants concerning their particular experiences during their four departure flights. The research team also asked for input from those participants who were given the information bulletin prior to their simulation flights to evaluate its effectiveness. In addition, the research team provided those participants who did not receive the bulletin prior to their flight with a copy, and solicited input from them as well. All debriefs were recorded for further post-simulation analysis.

4. Results

One potential benefit of RNAV SIDS is the reduction of the number, length, and complexity of voice communications without introducing ambiguity, and for the purposes of this study we operationally defined ambiguity as pilot to pilot uncertainty and/or pilot to ATC uncertainty. In order to identify different levels of uncertainty, the research team collectively developed a method for ranking crew performance using the information recorded by the flight crew observer, the frequency of contacts to ATC to confirm or clarify a clearance, and whether the flight crew demonstrated understanding by correctly executing ATC instruction. Table 2 outlines the five categories (1 being the most desirable and 4 & 5 being the least desirable).

Table 2. Crew performance categories

FLIGHT CREW	UNCERTAINTY (regarding clearance information, gathered from observed pilot to pilot interaction)	CONTACTS ATC to CONFIRM/CLARIFY CLEARANCE	DEMONSTRATES UNDERSTANDING. AND CORRECTLY EXECUTES ATC INSTRUCTION
CATEGORY 1	NO	NO	YES
CATEGORY 2	YES	NO	YES
CATEGORY 3	YES	YES	YES
CATEGORY 4	NO	NO	NO
CATEGORY 5	YES	YES	NO

In summarizing the data across the four test runs, flight crews had fewer clarifications with ATC in scenario number two compared to the other three. This particular scenario differed from the others in that the ATC phraseology used contained “Maintain Flight Level One Niner Zero” (the SID top altitude) in the clearance. The majority of flight crews were placed in category 1 for this scenario as there was no uncertainty observed, no clarification calls to ATC, and they correctly executed ATC instructions. It is important to note that every flight crew correctly executed all ATC instructions under this scenario. See Figure 1 for the summary of crew performance as a function of scenario type.

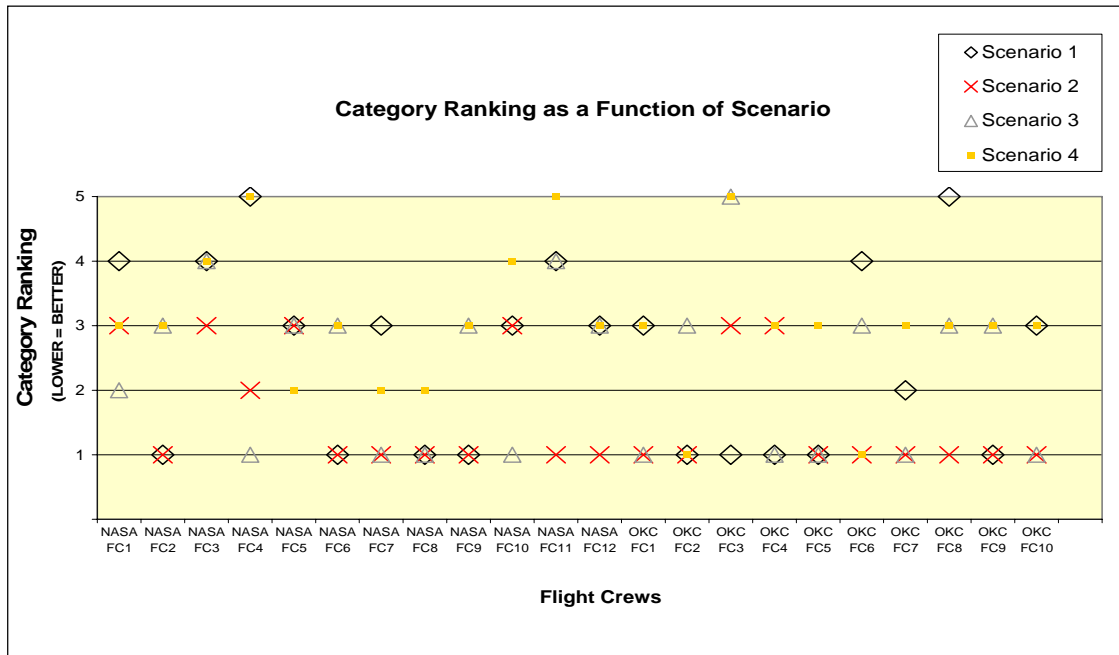


Figure 1. Pilot category data.

Figure 2 depicts the relationship between those participants who were given the information bulletin explaining the climb via procedures and associated phraseology prior to the simulation runs, and the other half of the participants who had no exposure to the bulletin as a function of scenario type.

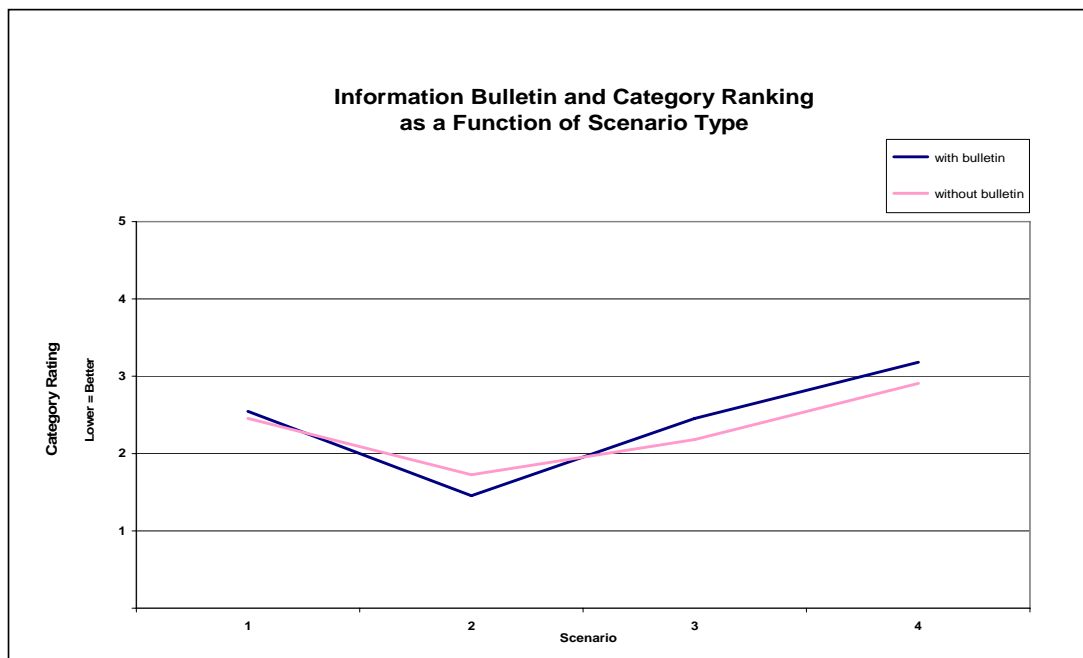


Figure 2. Information bulletin and crew rankings

In addition to the categorical data, feedback from the participants was solicited concerning the viability of the climb via procedure, how to improve the phraseology associated with RNAV departures, recommendations on how to enhance the information bulletin, and input on how to improve the departure plates.

The majority of participants agreed that lack of altitude information (or awareness of available altitude information) was a large contributor to ambiguity in the cockpit. The consensus among pilots who noticed the top altitude note depicted on the SID plate was that the altitude information needed to be more prominent. The participants who did not “catch” that information in their initial scans of the plate before each run, commented that the lack of that information coupled with absence of altitude information in the verbal clearance, contributed significantly to excess confirmation calls to ATC.

Similarly, the participants felt that when cleared to climb via direct-to a waypoint on the SID, altitude information should always be included in the clearance, regardless of whether altitude information is depicted for that waypoint. Furthermore, when a clearance involves rejoining a departure procedure, participants recommended that ATC should specify whether the SID and/or other specified altitude is to be reached with or without SID restrictions.

Specific examples of adopting participant recommendations are summarized in Table 3. The participants did not, in all cases, see or hear the entire modified clearances, and we therefore have feedback specifically regarding the full length of each modified clearance example.

Table 3. Participant Recommendations

Phraseology used during the simulation	Recommendations for phraseology modification
..climb via the SHEAD THREE RNAV departure	..climb via the SHEAD THREE RNAV departure, comply with restrictions
...climb via the SHEAD THREE RNAV departure, Except cross SHEAD at one four thousand, I say again cross SHEAD at one four thousand	climb via the SHEAD THREE RNAV departure comply with restrictions , Except cross SHEAD at one four thousand, I say again cross SHEAD at one four thousand
...traffic no longer a factor, climb via the SHEAD THREE RNAV departure, Maintain Flight Level one niner zero.	No change recommended
...proceed direct TARRK, climb via the SHEAD THREE RNAV departure, Maintain flight level one niner zero	No change recommended
...proceed direct TARRK, climb via the SHEAD THREE RNAV departure	...proceed direct TARRK, cross SHEAD at one-one thousand , climb via the SHEAD THREE RNAV departure, comply with restrictions
...proceed direct SHEAD, climb via the SHEAD THREE RNAV departure...	...proceed direct SHEAD, cross SHEAD at or above one four thousand , climb via the SHEAD THREE RNAV departure, comply with restrictions .

...fly heading two three zero, cross SHEAD at or above one four thousand, climb via the SHEAD THREE RNAV departure.	...fly heading two three zero to join the SHEAD THREE RNAV departure , cross SHEAD at or above one four thousand, climb via the SHEAD THREE RNAV departure, comply with restrictions .
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5. Discussion

The primary focus of this effort was the operational validation of draft “climb via” procedures and phraseology. Within the context of an RNAV SID, we also investigated issues surrounding the effective depiction of a “SID Top Altitude” (the highest altitude to which a pilot is cleared while “on” the given departure procedure). The goal was to exercise these new ATC instructions in an operational environment and assess the clarity of the climb via instruction through pilot performance and subjective feedback. The participant pool consisted of Boeing 747 and 737 pilots who had a wide range of prior RNAV SID experience.

Overall, the climb via concept was viewed favorably by the majority of the participants, and they were enthusiastic that the FAA was soliciting input from the user’s perspective prior to implementation. Most pilots agreed that with some minimal training, “climb via” would be beneficial to NAS operations.

Regarding the climb via phraseology, pilots maintained that they understand “comply with restrictions,” and that “climb via” was not fully intuitive. Pilots also commented that having the words “Maintain flight level one niner zero” in conjunction with the “climb via” clearances, reduced uncertainty. Participants also suggested that when ATC gives them a clearance to a SID waypoint, to always include altitude information in the ATC clearance, regardless of whether altitude information is depicted for that particular waypoint. Lastly, when a clearance involves joining a departure procedure between waypoints, include the operative word “join” in the clearance instruction.

With respect to the information provided on the standard departure plates, participants consistently remarked that the top altitude box (created for the purposes of our simulation) was insufficient. In fact, very few of the participants noticed this box. Pilots felt that a better approach would be to provide the top altitude information in a standardized location on all RNAV SID departure plates, and then “train” pilots to always refer to that location for SID top altitude information.

In addition, the participants had the opportunity to read and provide post-simulation feedback on an aircrew information bulletin explaining the climb via procedure and phraseology. With regard to this bulletin, one pilot recommended that clearly stating that “climb via” essentially means “comply with restrictions” would clarify the definition of climb via (additional text was copied/edited from the draft AIM DCP and is italicized below).

Climb via phraseology (aircrew information bulletin excerpts):

Clearance to “climb via” authorizes the pilot to vertically and laterally navigate on the SID. *Pilots are expected to comply with all remaining restrictions (i.e., altitude, airspeed SID “top altitude”, other) depicted on the SID after a “climb via” instruction is issued.*

The data indicate that regardless of exposure to the information bulletin that the climb via procedures and phraseology as simulated were not clear and/or concise enough to implement without some type of training.

6. Recommendations

The P/C PPAT has recommended the development of a web based aircrew training video describing the climb via phraseology and associated RNAV procedures. This approach is similar to what was done a few years ago when Precision Runway Monitor (PRM) procedures were implemented. In that example, pilots were directed to an FAA website that provided information about conducting closely spaced parallel approaches using the PRM. It also outlined the pilot training requirements for these procedures, which included mandatory viewing of a web based training video that highlights examples of pilots accepting clearances for simultaneous close parallel approaches and initiating those approaches.

The P/CPP AT recommends a similar concept for providing pilots with the phraseology and procedures associated with both RNAV and conventional departures. The RNAV training video should cover at least the following objectives:

- 1) General description of RNAV SIDs
- 2) “Climb via” definition (i.e., comply with restrictions)
- 3) Definition of SID Top Altitude, and where to find this information on the SID departure plate.
- 4) A review of correct flight deck programming (i.e., RWY, Departure, RTE, restrictions, etc.).
- 5) Several in-flight examples of correct cockpit procedures in response to ATC “climb via” clearances.

Following the completion of the training video, the research team recommends additional simulator activity. This would enable a replication of the phase II effort, were the video and training bulletin are shown to all flight crews prior to their participation. This would allow the P/C PPAT to evaluate the effectiveness of the training package before distribution. Furthermore, any feedback on enhancements on any information that need clarification could be obtained from the pilots and added to the final training package.

REFERENCES

Federal Aviation Administration (2004). *Air traffic control* (DOT/FAA/Order 7110.65P)
Washington, DC: Federal Aviation Administration.

Acronyms

AIM	Aeronautical Information Manual
AIP	Aeronautical Information Publication
ATC	Air Traffic Control
CRM	Crew Resource Management
CVSRF	Crew Vehicle Systems Research Facility
DME	Distance Measuring Equipment
DCP	Document Change Proposal
FAA	Federal Aviation Administration
FMS	Flight Management System
GPS	Global Positioning System
HUD	Heads-up Display
LAS	Las Vegas/McCarran International Airport
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
P/PPAT	Pilot Controller Phraseology and Procedures Action Team
PRM	Precision Runway Monitor
RNAV	Area Navigation
RNP	Required Navigation Performance
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival Route
WJHTC	William J. Hughes Technical Center

Appendix A
Draft Document Change Proposal (DCP)

Draft Document Change Proposal (DCP)

6.1.1.1 DOCUMENT CHANGE PROPOSAL/BRIEFING SHEET

ORDER/PUBLICATION: 7110.65P

CHANGE: 1

EFFECTIVE DATE: 2/xx/05 **TRACKING #:** **REV DATE: 1/13/04**

SPECIALIST/ROUTING: Bruce Tarbert, ATP-500

1. PARAGRAPH NUMBER AND TITLE:

4-5-7, ALTITUDE INFORMATION

2. BACKGROUND: The Pilot/Controller Procedures and Phraseology Action Team (P/CPP AT) was established to address pilot/controller procedure and phraseology issues. The P/CPP AT is made up of air traffic, aviation, and union subject matter experts and propose changes to the FAA Order 7110.65, AIM and AIP. The P/CPP has validated an operational need to establish “climb via” using procedures and phraseology that mirror “descend via” .

3. EXPLANATION OF CHANGE: New procedures and phraseology is added to paragraph 4-5-7 to describe the “climb via” instructions.

4. CHANGE:

OLD

NEW

4-5-7. ALTITUDE INFORMATION

4-5-7. ALTITUDE INFORMATION

Issue altitude instructions as follows:

Issue altitude instructions as follows:

a. through i. No Change.

a. through i. No Change.

j. Add

j. Instructions to vertically navigate on a SID with published restrictions must be issued after an aircraft is taken off a SID and then asked to resume the SID or after the aircraft is given an altitude restriction

that stops the normal climb on a SID.

PHRASEOLOGY-

CLIMB VIA (SID name and number)

EXAMPLE-

“Climb via the Mudde One Departure.”

NOTE 1-

Clearance to “climb via” authorizes pilot:

1. To vertically and laterally navigate on a SID.

2. When cleared to a waypoint depicted on a SID, to climb from a previously assigned altitude at pilots discretion to comply with the altitude information depicted for that waypoint, and once established on the depicted departure, to navigate laterally and vertically to meet all published restrictions.

3. While an aircraft is off the assigned procedure, ATC is responsible for obstacle clearance when issuing a “climb via” clearance from a previously assigned altitude.

REFERENCE- (check these refs)

FAAO 7110.65, Minimum En Route Altitudes, Para 4-5-6.

FAAO 7110.65, Separation From Obstructions, Para 5-5-9.

NOTE 2-

When changing frequencies, pilots cleared for vertical navigation using the phraseology "climb via" shall inform ATC upon initial contact. There is no need to inform subsequent ATC sectors of the

“climb via” instruction after the first report.

EXAMPLE-

“Delta One Twenty One leaving 120, climbing via the Aces Two departure.”

1. Aircraft on a “direct-to” routing to a waypoint/fix on a SID shall be assigned an altitude to cross the waypoint/fix if no altitude is depicted at the waypoint/fix.

EXAMPLE-

“Proceed direct Decay, cross Decay at or above six thousand, climb via the Aces Two Departure.”

2. If it is necessary to assign a crossing altitude which differs from the SID altitude, emphasize the change to the pilot.

PHRASEOLOGY-

CLIMB VIA THE (SID) EXCEPT CROSS (Fix, Point, Waypoint), (revised altitude information).

6.1.1.2 EXAMPLE-

“Climb via the Aces Two departure except cross Aces at or above one six thousand.”

6.1.1.3 NOTE-

The aircraft should track laterally and vertically on the Aces Two arrival and should climb so as to cross Aces at or above 16,000; remainder of the departure shall be flown as published.

REFERENCE-

FAAO 7110.65 Departure Clearances, Para 4-3-2.

AIM, Instrument Departure Procedure (DP), Para 5-2-6

3. If it is necessary to assign an interim altitude, or assign a final altitude, not contained on a SID, advise the pilot where the interim or final altitude begins.

6.1.1.4 PHRASEOLOGY-

CLIMB VIA THE (SID) EXCEPT AFTER (fix) MAINTAIN (revised altitude information).

EXAMPLE-

“Climb via the Aces Two departure, except after Aces, maintain one five thousand.”

6.1.1.5

6.1.1.6 NOTE-

The aircraft should track laterally and vertically on the Aces Two departure and should climb so as to comply with all speed and altitude restrictions until reaching Aces and then maintain 15,000. to climb. Upon reaching 15,000, aircraft should maintain 15,000 until cleared by ATC to continue

Appendix B
Participant Consent Form

Consent Form

I, _____, understand that the FAA Air Traffic Procedures Office (ATP-500) and FAA Flight Standards sponsor and direct this effort entitled *Evaluation of Modified Air Traffic Control Phraseology for Area Navigation (RNAV) Standard Instrument Departure Clearances*.

I. Nature and Purpose:

I agree to volunteer as a participant in the study cited above. I understand the purpose of this evaluation is to provide the feedback on the utility, effectiveness, and safety of the proposed new controller phraseology for communicating RNAV SIDS to pilots. I will make recommendations and suggestions with respect to procedural, communication, and/or other relevant issues that would enhance the understanding of new RNAV SIDS departure phraseology.

II. Participant Responsibilities:

My information will be gathered through narrative descriptions of the actions I would take within the cockpit in the context of selected RNAV departure scenarios in order to characterize the nature of any potential problem(s) that may exist in interpreting and executing RNAV SID clearances using the proposed “climb via” phraseology.

III. Discomforts and Risks:

There are no expected discomforts or risks associated with this experiment.

IV. Participant Assurances:

I understand that my participation in this study is completely voluntary. I understand that if new findings develop during the course of this research that may relate to my decision to continue to participation, I will be informed. I understand that I can withdraw from the study at any time without penalty or loss of benefits to which I may be entitled. I also understand that the researcher of this study may terminate my participation if he/she feels this to be in my best interest.

I understand that records of this study are strictly confidential, and that I will not be identifiable by name or description in any reports or publications about this study

I have read this consent document. I understand its contents, and I freely consent to participate in this study under the conditions described. I have received a copy of this consent form.

Research Participant : _____ Date: _____

Appendix C
Information Bulletin

Crew Information Bulletin

This draft aircrew information bulletin contains information regarding the new “CLIMB VIA” phraseology being introduced for use with Standard Instrument Departures (SIDs). While this phraseology was developed specifically in response to ambiguity, discrepancies, and deviations occurring on RNAV SIDs, it is equally applicable to non-RNAV SIDs. Each operator should adapt this information bulletin to their specific flight deck systems and operating procedures.

With the addition of new “RNAV SID’s” (AIM 5-2-6 f.) appearing at more airports within the NAS, the need for understanding the terminology associated with these procedures is critical to their successful introduction. The “CLIMB VIA” phraseology (ref: FAA Order 7110.65) was developed to address problems (deviations/non-compliance) reported on RNAV SIDs. Corresponding information will also be added to the AIM and AIP.

The operational conditions in which the “CLIMB VIA” phraseology is most needed are:

- (1) After a controller has taken an aircraft “off” a SID at least laterally, and then specifies instructions to resume the SID (to navigate on a SID with published restrictions)
- (2) When the controller has taken the aircraft “off” the SID vertically only by issuing an altitude restriction that alters any portion of the published SID climb profile.

CLIMB VIA PHRASEOLOGY (FAA Order 7110.65 excerpts): SEE REVERSE

FLIGHT DECK RNAV SYSTEM IMPLICATIONS:

Pilots should confirm the appropriate RWY, Departure, and Transition information is loaded in the flight deck RNAV system (e.g. Flight Management System, etc.), and that any RNAV or RNP procedure is retrievable (for loading) by the procedure name from the aircraft database and conforms to the charted procedure.

Pilots should cross check the loaded procedure with the charted procedure and ATC departure clearance.

Pilots should avoid premature manual deletion of WPTs from their active “legs” page when vectored off a SID to allow for rejoining procedures.

PILOT MONITORING SID COMPLIANCE:

If the pilot is unclear regarding the current assigned altitude, level off “top altitude” or climb profile (SID depicted, ATC provided, etc) the pilot should request clarification from ATC.

Pilots should monitor each leg of a SID in order to anticipate aircraft compliance with published SID restrictions and/or other ATC provided clearances (e.g. fly-by or fly-over WPTs, altitude restrictions, and speed restrictions, cross track error).

If available, pilots should use course deviation indicator (CDI), and/or flight director guidance per the SID charted instructions.

Appendix D
Scenario descriptions and associated ATC phraseology

Scenario Descriptions

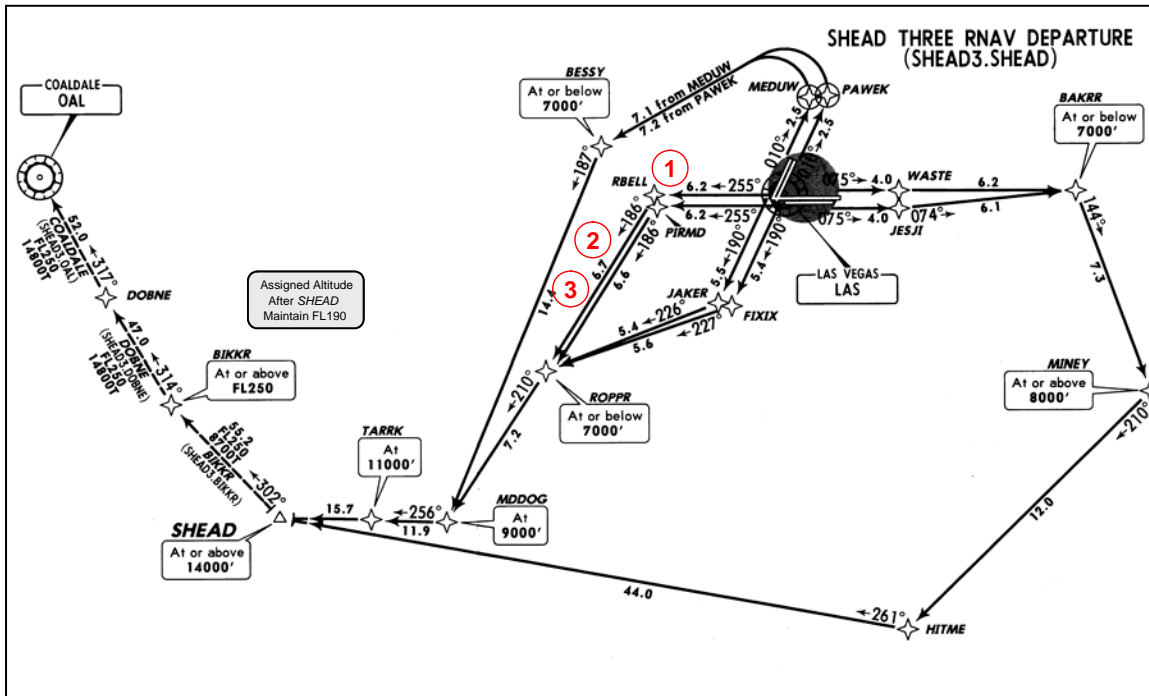


Figure 3. Scenario 1: Speed change and downstream SID restriction change

ATC Phraseology

- American 1721, cleared to SEA, via the SHEAD THREE RNAV departure COALDALE transition as filed, squawk 2432
- American 1721, taxi to 25R
- American 1721, taxi into position and hold: cleared for takeoff
- American 1721, Contact Departure 125.9
- American 1721, Radar Contact
- 1. American 1721, reduce speed to two-three zero (should be issued at about 5700').**
- 2. American 1721, resume normal speed**
- 3. American 1721, climb via the SHEAD THREE RNAV departure, except cross SHEAD at one four thousand, I say again cross SHEAD at one four thousand.**
- American 1721, contact LA Center 124.25

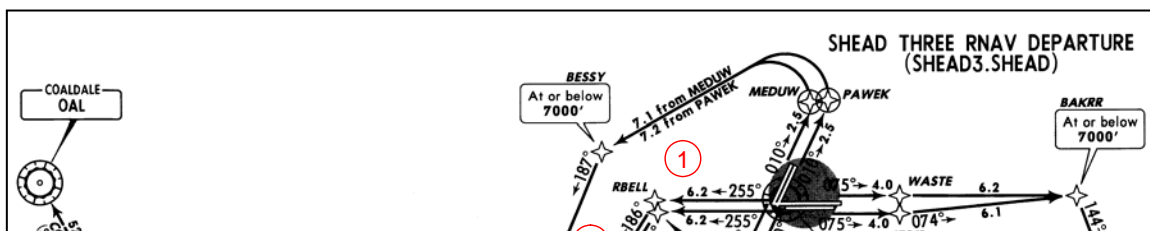


Figure 4. Scenario 2: Altitude restriction change, followed by a short-cut.

ATC Phraseology

- American 1721, cleared to SEA, via the SHEAD THREE RNAV departure COALDALE transition as filed, squawk 2432
- American 1721, taxi to 25R
- American 1721, taxi into position and hold: cleared for takeoff
- American 1721, Contact Departure 125.9
- American 1721, Radar Contact
- **1. American 1721, maintain seven thousand for traffic expect higher in ten miles.**
- **2. American 1721, traffic no longer a factor CLIMB VIA the SHEAD THREE RNAV departure, MAINTAIN FLIGHT LEVEL ONE NINER ZERO**
- **3. American 1721, proceed direct TARRK, climb via the SHEAD THREE RNAV departure, MAINTAIN FLIGHT LEVEL ONE NINER ZERO**
- American 1721, contact LA Center 124.25

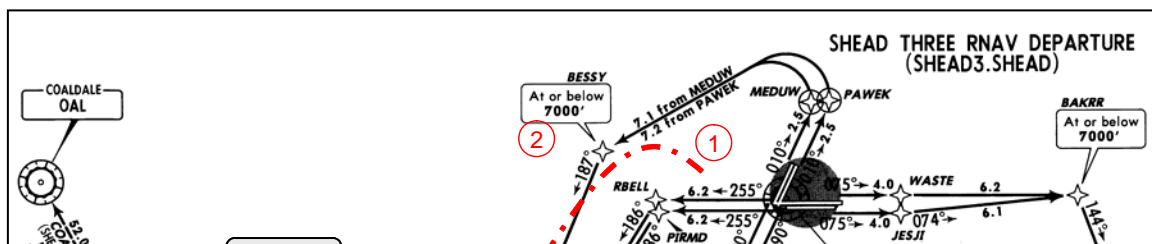


Figure 5. Scenario 3: Vector off departure (w/heading and altitude restriction), followed by a short-cut back on SID.

ATC Phraseology

- American 1721, cleared to SEA, via the SHEAD THREE RNAV departure COALDALE transition as filed, squawk 2432
- American 1721, taxi to 25R
- American 1721, taxi into position and hold: cleared for takeoff
- American 1721, Contact Departure 125.9
- American 1721, Radar Contact
- **1. American 1721, Fly heading two seven zero, vector for spacing maintain seven thousand, expect direct TARRK.**
- **2. American 1721, Proceed direct TARRK, CLIMB VIA the SHEAD THREE RNAV departure**
- American 1721, contact LA Center 124.25

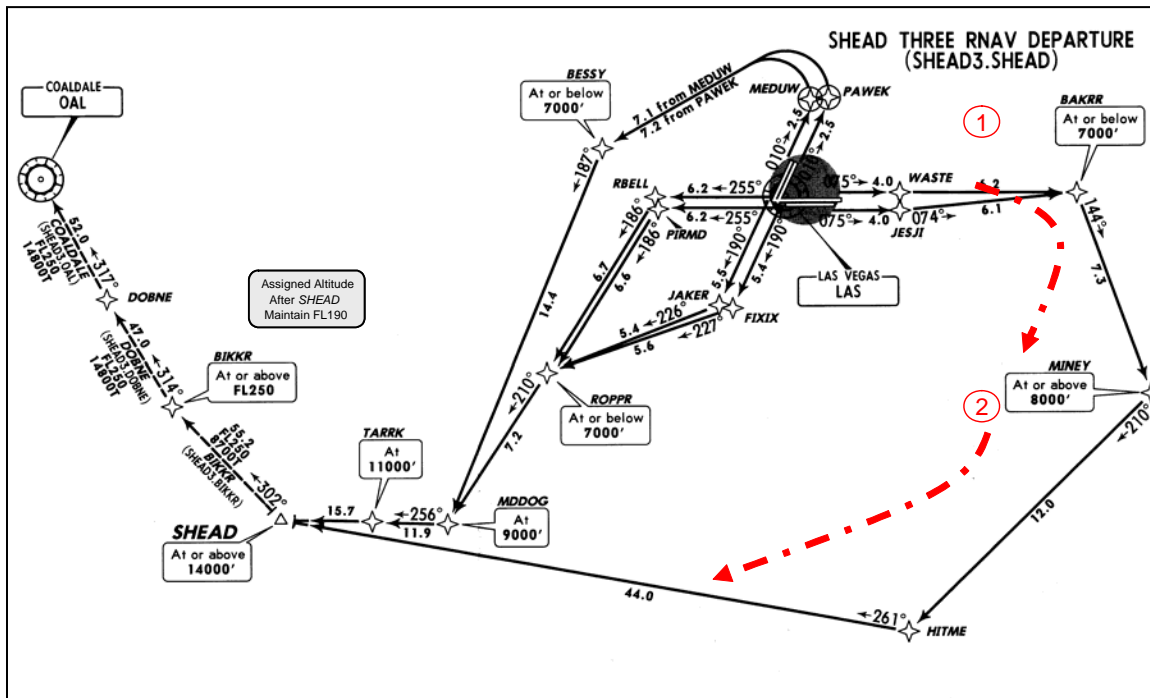


Figure 6. Scenario 4: Short-cut, followed by a vector and clearance to CLIMB VIA

ATC Phraseology

- American 1721, cleared to SEA, via the SHEAD THREE RNAV departure COALDALE transition as filed, squawk 2432
- American 1721, taxi to 7L
- American 1721, taxi into position and hold: cleared for takeoff
- American 1721, Contact Departure 125.9
- American 1721, Radar Contact
- 1. American 1721, Proceed direct HITME maintain niner thousand, expect vectors to resume the SHEAD THREE RNAV departure.**
- 2. American 1721, Fly heading two three zero, Cross SHEAD at or above one four thousand, CLIMB VIA the SHEAD THREE RNAV departure**
- American 1721, contact LA Center 124.25

Appendix E
SHEAD THREE SID Plate with Top Altitude Note

Figure 7. SHEAD THREE Departure Plate

